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LIMITED ASSESSMENT OF MACCHI MB-326H HANDLING CHARACTERISTICS W--ETC (U)
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ROYAL AUSTRALIAN AIR FORCE



AIRCRAFT RESEARCH AND DEVELOPMENT UNIT

FLIGHT TEST REPORT

LIMITED ASSESSMENT OF MACCHI MB-326H HANDLING
CHARACTERISTICS WITHOUT TIP TANKS FITTED

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A Macchi MB-326H was modified by removing the tip tanks and fitting tip fairings. Flight tests demonstrated that, although the handling characteristics in normal flight were not markedly affected, the better lateral response and increased performance made the modified aircraft more pleasant to fly. Removal of the tip tanks made the aircraft's erect spin much more oscillatory, and on occasions the gyrations were violent. Nevertheless, the aircraft always recovered quickly from the spin when standard spin recovery action was taken.

As a result of the changes to the handling characteristics, the modified aircraft could be used to provide pre-test pilot course training. Operating procedures and limitations to be imposed when operating the aircraft in the modified state were also determined during the test programme.

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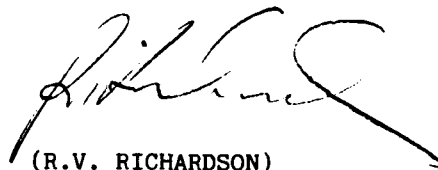
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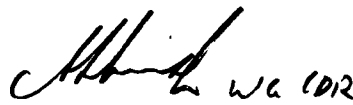


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AIRCRAFT RESEARCH AND DEVELOPMENT UNIT

TECHNICAL NOTE AERO 73

LIMITED ASSESSMENT OF MACCHI MB-326H HANDLING
CHARACTERISTICS WITHOUT TIP TANKS FITTED

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As a result of the changes to the handling characteristics, the modified aircraft could be used to provide pre-test pilot course training. Operating procedures and limitations to be imposed when operating the aircraft in the modified state were also determined during the test programme. ↑

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REPORT NO TN AERO 76

LIMITED ASSESSMENT OF MACCHI MB-326H HANDLING
CHARACTERISTICS WITHOUT TIP TANKS FITTED

INTRODUCTION

Background

1. Aircraft Research and Development Unit (ARDU) identified a requirement for an aircraft, held on the unit's establishment, which displayed unique handling characteristics. Such an aircraft would provide a vehicle for pre-test pilot course training of personnel posted to overseas flight test establishments.

2. Modification of a Macchi MB-326H by removing the tip tanks and fitting suitable tip fairings was considered a quick and efficient way of providing such an aircraft. Because of its role as a trainer in the RAAF, aircrew posted to undergo test pilot training would be acquainted with the Macchi. The aircraft and its systems would therefore be familiar to the trainees but, with tip tanks removed, may exhibit different handling characteristics when compared to the standard aircraft.

Task

3. Technical Note Aero 73 was raised by CO ARDU and tasked the project officer to make an initial study to assess the feasibility of the modification and to define the handling characteristics which may be affected. Provided this study revealed no reason for not proceeding, a Macchi was to be modified according to the requirements of Paragraph 2. An assessment of aircraft handling characteristics in the following flight regimes was then to be made:

- a. low speed (take-off and landing);
- b. stall and post-stall;
- c. spinning; and
- d. high Mach.

Description of Test Aircraft and Instrumentation

4. Macchi A7-080 was used as the test aircraft. The aircraft's condition was generally good and the airframe had flown approximately 2,170 hours at completion of the tests.

5. Standard cockpit instrumentation was used during the tests. Additionally, a stopwatch was used to measure aircraft roll and turn rates. Data were recorded manually and on a mini-cassette tape recorder.

Initial Feasibility Study and Modification Development

6. Information on the aircraft's characteristics with tip tanks removed was sought direct from the manufacturer, Aeronautica Macchi. Some detailed performance information was obtained which showed a slight change to the aircraft's drag polar at MO.65. No quantitative data on the aircraft's handling characteristics was available. The only tests carried out were of a limited, qualitative nature and were performed many years ago. However, Macchi's chief

test pilot advised that, in general, the differences in handling characteristics were minor, and that the aircraft was slightly more spin resistant. Additional information was also obtained from Reference A. This document reported on model spinning tests of the MB-326, with and without tip tanks fitted, in the Royal Aircraft Establishment (Farnborough) spinning tunnel.

7. A short paper discussing, in qualitative terms, possible changes to the aircraft's handling characteristics was prepared. A copy of the paper is attached at Annex A. Assessment of the changes to weight, centre of gravity (CG) and mass distribution was made using data applicable to Macchi A7-005. This aircraft was not available when flight testing commenced and A7-080 was used. However, the changes detailed in Annex A showed that the aircraft remained well within the prescribed weight and CG limitations with the tip tanks removed. Because the changes were small, no additional calculations applicable specifically to A7-080 were considered necessary.

8. Modification of the wing tips for flight without tip tanks was developed by Maintenance Squadron staff - such a modification was not technically difficult. Once the modification had been developed, removal of the tip tanks and fitment of the tip fairings required expenditure of only 3 manhours. Re-installation of the tip tanks required 4 manhours. A detailed description of the modification is contained in Reference B. A general view of the aircraft and a close-up photograph of the wing-tip in the modified state are shown in Annexes B and C respectively.

9. As a result of the information obtained during this feasibility study, the decision was made to continue with flight tests.

RESULTS AND DISCUSSION

Preliminary Flights

10. Four preliminary flights were made with empty 320 litre tip tanks fitted to the aircraft. These flights were used to assess the characteristics of the test aircraft in the standard configuration and to provide baseline data for comparison. The flights were also considered necessary because several aircraft in the RAAF's Macchi fleet had developed characteristics which were not typical of the majority of the aircraft. These atypical characteristics usually included violent aileron snatch during accelerated stalls and altered autorotative and spinning characteristics.

11. The preliminary flights included:

- a. determination of stall speeds and assessment of stall characteristics;
- b. assessment of take-off and landing handling characteristics;
- c. determination of rates of roll;
- d. assessment of longitudinal, lateral and directional stability; and
- e. assessment of erect spinning characteristics.

During the stalls carried out in the landing configuration, the control column floated to the right when the speed reduced to approximately 100 KIAS. A light force (about 1-2 lbf) was required to maintain the ailerons neutral during the remainder of the approach to the stall. Apart from this feature, the aircraft exhibited no atypical characteristics during these initial tests and appeared representative of fleet aircraft. The characteristics of the standard aircraft

are well documented and will neither be described nor discussed in this report.

Operating Procedures - Tip Tanks Removed

12. The first two flights with the tip tanks removed were used to investigate general handling characteristics and to define operating procedures during the take-off and landing phases. Tests were performed to assess the following:

- a. stall speeds and stalling characteristics in the take-off and landing configurations;
- b. handling during take-off and landing;
- c. longitudinal, lateral and directional stability, and rates of roll in the take-off and landing configurations.

13. Stalling. Stall warning in both configurations was indicated by general airframe buffet which commenced at 2-3 KIAS before the stall. Removal of the tip tanks resulted in slightly increased stall speeds. At equivalent all-up-weights (AUW), the stall speed was increased 2-3 KIAS in the landing configuration and 3-4 KIAS in the take-off configuration. Aircraft handling characteristics in the stall and during the recovery were unchanged. The movement of the control column mentioned in paragraph 11 was still evident.

14. Take-off and Landing. The tests were aimed at assessing the handling characteristics and establishing minimum safe flying speeds in both straight and turning flight. In all cases, the aircraft could be flown accurately at speeds down to the onset of stall warning buffet. The response to control inputs was adequate to cope with turbulence and normal take-off, approach and landing manoeuvres.

15. Stability. Standard flight test techniques were used to briefly assess the aircraft's static and dynamic stability. Removal of the tip tanks caused no significant changes to the characteristics. The only noticeable change occurred during turns on rudder alone with ailerons free. In both the take-off and landing configurations, with approximately $\frac{1}{2}$ - $\frac{2}{3}$ rudder applied, the aircraft initially entered a turn in the direction of the applied rudder. However, after a few seconds the ailerons floated to a position to oppose the turn induced by the rudder (ie. with right rudder applied the control column floated 2-3 inches left of neutral). The direction of turn then reversed even though the rudder position was maintained. Only a light force of approximately 1-2 lbf was required to maintain the ailerons neutral, in which case the aircraft continued to turn in the direction of the applied rudder. While the characteristic described above demonstrated a difference due to removal of the tanks, it was not operationally significant.

16. Rate of Roll. Rates of roll through 60° were measured using the aircraft attitude indicator and a stopwatch. The AUW during the tests was approximately 7,200 lbf. The aircraft was initially stabilized in a turn at 30° angle of bank. Full aileron was then used to roll to 30° angle of bank in the opposite direction. The rudder was maintained neutral throughout. Rolls were made to both the left and the right and the times presented in Table 1 are an average of the two. There was no significant difference between the aircraft's roll performance to left and right. A comparison of the aircraft's roll performance with tip tanks on and off is shown at Table 1 below. As shown in the table, the time to roll through 60° was decreased by 15-17% when the tip tanks were removed. The results indicate that any reduction in aileron effectiveness caused by removal of the tanks was more than compensated for by the reduction in roll inertia and roll damping. This conclusion was also supported by a qualitative assessment that aircraft lateral response to both gusts and control inputs was noticeably increased.

TABLE 1 - TIME TO ROLL THROUGH 60°

Configuration	Altitude (ft)	Speed (KIAS)	Time (sec)	
			Tip Tanks ON	Tip Tanks OFF
Take-off	5,000	120	1.9	1.6
Landing	5,000	110	2.3	1.9

17. Operating Procedures. The tests described in Paragraphs 13 to 16 demonstrated that the aircraft was safe to fly with the tip tanks removed. The stall speeds at equivalent AUWs were increased. Therefore, although operating at reduced AUWs, lift off and threshold speeds should not be reduced. The following speeds were calculated to provide the same margin from the stall as is provided by the current operating procedures for the standard aircraft, and should be used when operating the aircraft with tip tanks removed:

a. Take-off Speed:

(1) Nosewheel Off - 85 KIAS.

(2) Lift Off - 95 KIAS.

b. Landing Threshold Speed:

(1) Land flap, fuel \geq 800 lbf - 105 KIAS.

(2) Land flap, fuel < 800 lbf - 100 KIAS.

(3) Flapless - add 10 KIAS to the above speeds.

All other operating procedures should remain as specified for the standard aircraft.

Handling Characteristics and Performance during Normal Flight

18. Seven further flights were made by the project officer. The aircraft was also flown by a majority of the test pilots at ARDU. During these flights, aircraft characteristics in all phases of flight were qualitatively assessed. Although the tests were designed specifically to investigate aircraft handling qualities, an assessment of the increased performance was made by briefly checking climb and cruise performance.

19. General Flying. Aircraft handling characteristics were not greatly affected by the modification. However, lateral response was increased (Paragraph 16 refers). This feature, combined with the improved performance due to the reduced weight and drag, made the aircraft more crisp and pleasant to fly than in the standard configuration. Aircraft climb and cruise performance, compared to data for the standard aircraft obtained from Reference C, is shown at Table 2. The Reference C climb information was obtained from figure A1-9 because the climb data shown at figure A1-10 did not include an allowance for the take-off roll.

TABLE 2 - CLIMB AND CRUISE PERFORMANCE

Configuration	Climb to 30,000 ft from Brakes Release			Cruise at 30,000 ft/0.59 IMN		
	Time (min)	Fuel Used (lb)	Temperature (°C)	RPM (%)	Fuel Flow (lb/hr)	Temperature (°C)
No Tip Tanks	13.4	380	ISA + 3 to + 6	90	750	ISA + 3
320 l Tip Tanks	18.5	530	ISA + 5	93	850	ISA + 3
No Tip Tanks	12.75	360	ISA - 1 to + 3	-	-	-
320 l Tip Tanks	17.5	490	ISA	-	-	-

An additional indication of increased performance was obtained when the aircraft was flown in formation with another Macchi fitted with 320 litre tip tanks. The aircraft with tanks and the additional fuel required 3-5% more RPM to maintain formation with A7-080.

20. High Mach Flight. The test aircraft was flown to 0.82 Indicated Mach Number (IMN). A progressive nose down trim change (typical of the standard aircraft) occurred as the Mach Number increased. Light airframe buffet occurred above 0.90 IMN. A 3½ g dive recovery was made - slight aileron snatch occurred during the recovery but was easily held.

Spin Characteristics

21. Aircraft spin characteristics were noticeably changed by removal of the tanks. Because of the extent of this change, a majority of the flights made with the tip tanks removed were used to investigate the spin. The project officer performed a total of 30 developed erect spins. The other test pilots who flew the aircraft also performed erect spins in the aircraft. Entry heights varied between 15,000 and 35,000 feet. Without an automatic recording instrumentation system, accurate quantitative data could not be obtained. Furthermore, because of the dynamic nature of the spin, aircraft often display different characteristics in each spin and a completely accurate qualitative description can be difficult to compile. The following paragraphs give a general description of this aircraft's overall spinning characteristics and no attempt has been made to detail all variations which may occur.

22. Spin Entry Techniques and Entry Behaviour. Most of the spins were entered from straight and level flight by simultaneously applying full back stick and full rudder at 100 - 110 KIAS. Whilst the aircraft readily entered a spin, it exhibited different entry behaviour to the left and right. During the left entry, the aircraft pitched up about 15° then rolled quite slowly to the left through about 90°. The nose then dropped to 70-80° below the horizon as the aircraft passed from 90° to 180° of roll. The first turn (ie. 360° of roll) took 6-8 seconds and by the end of the turn the aircraft was entering the developed phase of the spin. During the right entry, the aircraft again pitched up about 15° then rolled but, in this case, more quickly. The first 360° of roll took 3-5 seconds and the aircraft continued in approximately horizontal flight. In the next ¼ - ½ turn, the nose dropped rapidly to 70-80° below the horizon and at completion of 1½ turns was entering the developed spin. A limited number of

entries were made from higher speeds which resulted in more dynamic and variable aircraft motions. The motions depended upon the exact technique used but on no occasion did dangerous gyrations occur.

23. Developed Spin Behaviour. In general, the aircraft exhibited a more oscillatory spin than the standard aircraft. During the first 4 turns of a spin to the left, the aircraft rotated at the rate of about one turn every 3-3½ seconds and descended 700 - 800 feet per turn. During that time, the indicated airspeed increased steadily from 100-110 KIAS to 175-180 KIAS. After about 5 turns, the spin appeared to stabilize with the airspeed reasonably constant at 175-180 KIAS and the aircraft making one turn every 2½-3 seconds. The right spin was a markedly more oscillatory, and on occasions violent, manoeuvre. The aircraft exhibited large changes in roll, yaw and pitch rate, although the most obvious feature was a hesitation in the roll rate. The hesitations occurred approximately once per turn but this varied. Consequently, the turn rate and height loss per turn also varied - on average the aircraft took 3½-5 seconds per turn and lost 700-1,000 feet. Although the average turn rate of the right spin was lower than the left, the maximum angular accelerations generated in the right spin were much higher. These high accelerations usually occurred after a roll hesitation and imposed high loads on the aircraft and its occupants. On occasions, the aircraft appeared as though it was about to tumble, although this never occurred. The indicated airspeed oscillated erratically during the right spin and reached a maximum of 180 KIAS after about 5 turns. Although it fluctuated over a large range, the maximum observed speed never exceeded this value. Spins of up to nine turns were carried out.

24. Effect of Aileron Application. The effect of aileron application was investigated by applying aileron at different phases of the spin. Aileron was applied during spin entry, after one turn following an entry using standard control movements, and during the developed spin. On most occasions, application of out-spin aileron caused no marked change to the spin characteristics. It did appear to slightly reduce the magnitude of the roll hesitations in the right spin. However, on three occasions (during two left spins and one right spin) out-spin application after one turn stopped the aircraft's rotation completely. The aircraft ended up in a steep, sideslipping dive with the airspeed increasing. Application of in-spin aileron appeared to slightly increase the turn rate of the left spin but no other significant changes were apparent. During the right spin, application of in-spin aileron caused a slight increase in the magnitude of the oscillations.

25. Recovery. A variety of recovery techniques were investigated. They included controls free recovery, recovery with aileron applied and the standard recovery detailed in Reference C. On all occasions the aircraft recovered rapidly. With controls free the aircraft recovered in approximately 1½ turns. On all other occasions recovery was rapid in ½ to ¾ of a turn.

26. Differences in Characteristics. Because of the limited nature of the tests, no attempt was made to investigate and explain the aircraft's different left and right autorotative and spinning characteristics. There may have been small asymmetries in aircraft rigging or some affect associated with the direction of engine rotation which could explain the differences. However, such investigation was considered outside the scope of this Technical Note.

Flight Clearance and Operating Limitations

27. Flight Clearance. The flight tests demonstrated that Macchi A7-080 with tip tanks removed could safely perform all manoeuvres for which the standard aircraft was cleared. However, because the spin could be very oscillatory and occasionally showed a tendency to tumble which could lead to an inverted spin, spin entries should not be made below 20,000 feet. If the aircraft did inadvertently enter an inverted spin, the manoeuvre would be very disorientating. A minimum entry height of 20,000 feet should provide the pilot with

sufficient time to assess the situation and take appropriate recovery actions. No inverted spins were carried out during the test programme but experience of erect spin behaviour and recovery characteristics indicated that the recovery technique described in Reference C would be effective. Therefore, before spinning the aircraft with tip tanks removed, aircrew should refamiliarize themselves with inverted spinning information contained in Reference C.

28. Operating Limitations. Removal of the tip tanks probably results in a more severe fatigue loading spectrum because of the increased wing root bending moments. Conservative operating limitations were therefore placed on the test aircraft to reduce inertia and aerodynamic loads. Because of the limited role envisaged for the modified aircraft, these limitations are not considered restrictive. In addition to standard aircraft limitations, the following limitations should be imposed when the aircraft is modified to remove the tip tanks:

a. Acceleration:

- (1) symmetric manoeuvres +4.5 to -1.5 g.
- (2) asymmetric (full aileron) manoeuvres +3.0 to -1.0 g.

b. Speed V_{NE} 360 KIAS/0.8 IMN.

CONCLUSIONS

29. The test programme demonstrated that the Macchi MB-326H could be safely operated with tip tanks removed. Although the handling characteristics in normal flight were not markedly affected, the better lateral response and increased performance combined to make the aircraft more pleasant to fly. Aircraft spin characteristics were significantly changed by the removal of the tanks. Despite the oscillatory, and occasionally violent, nature of the spin, the aircraft always recovered rapidly when standard spin recovery action was taken.

30. As a result of these changes to the characteristics in this configuration, the aircraft could provide useful pre-test pilot course training. If the aircraft is operated in the modified state, the operating procedures and limitations detailed in paragraphs 17 and 28 of this report should be observed. Before spinning the aircraft, the additional procedures detailed in paragraph 27 should also be followed.

REFERENCES

- A. Technical Note Aero 2489 RAE Farnborough 'Model Spinning Tests on a Jet Trainer (Macchi MB-326)', D.R. Dennis, December 1976.
- B. ARDU NSM Macchi 103 - Installation of Tankless Wingtips.
- C. AAP 7212.001-1 Flight Manual Macchi MB-326H, October 1976 (Amendment List No 4).

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MACCHI MB-326H HANDLING CHARACTERISTICS:
POSSIBLE EFFECTS OF REMOVING WING TIP TANKS

Reference: A. TN AERO 56, 'Macchi MB-326H Spinning Characteristics Comparison of In-flight Trials Data with Spinning Theory', August 1973.

Introduction

1. Removal of the tip tanks from Macchi MB-326H aircraft will result in changes to the shape, surface area, weight and balance of the airframe. Changes in the aircraft's performance and handling characteristics due to the weight, mass distribution and aerodynamic variations can therefore be expected.

2. Accurate quantitative predictions of the changes could only be achieved after considerable detailed study, including wind tunnel tests on scale models. This paper does not attempt to make such predictions and will merely discuss very briefly, and in qualitative terms, the flight regimes in which changes to the aircraft handling characteristics may occur.

Changes to Weight, CG and Moments of Inertia

3. Weight and CG. The calculations shown at Table 1 were made using the latest weighing record (dated 5SEP79) of Macchi A7-005.

TABLE 1 - A7-005 WEIGHT AND CG

Configuration	Weight (lbf)	CG (inches aft of) datum/%SMC	Moment (in lbf)
Zero Fuel 320 l Tip Tanks Fitted	5,760	194.5/32.5	1,120,500
Zero Fuel Tip Tanks Removed	5,610	194.3/32.1	1,089,900
Full Internal Fuel Tip Tanks Removed 2 x Crew	7,410	188.3/24.2	1,395,300
300 lbf Internal Fuel Tip Tanks Removed 2 x Crew	6,350	189.5/25.7	1,203,300

Notes: 1. Fuel SG = 0.79
2. Weight of each crew member assumed to be 220 lbf
3. CG limits are 186.7 to 192.6 inches aft of datum/22 to 30%SMC

4. Moments of Inertia. Approximate Moments of Inertia were obtained from calculations made in Reference A. The absolute values will have changed slightly since those calculations were made but are considered of sufficient accuracy for the purposes of this paper. The moments of inertia for various configurations are shown in Table 2.

TABLE 2 - A7-005 MOMENTS OF INERTIA

Configuration	Moments of Inertia			B/A
	A Slug-ft ²	B Slug-ft ²	C Slug-ft ²	
320 1 Tip Tanks, Full Fuel, 2 x Crew	14,515	7,880	21,900	0.54
320 1 Tip Tanks Empty, 300 lbf Internal Fuel, 2 x Crew	4,785	7,830	12,075	1.64
Tip Tanks Removed, Full Internal Fuel, 2 x Crew	3,360	7,845	10,650	2.33
Tip Tanks Removed, 300 lbf Internal Fuel, 2 x Crew	3,360	7,830	10,635	2.33

Changes in Handling Characteristics

5. CG Position. As shown in Table 1, the CG of the aircraft remains well within limits when the tip tanks are removed. The aircraft's longitudinal stability will be similar to the standard aircraft and, as a result, no handling characteristics will change due to the CG position of the modified aircraft.

6. Moments of Inertia. An aircraft's mass distribution, as described by its moments of inertia, has an important influence upon its spinning characteristics. The B/A ratio is a useful parameter in predicting these characteristics. As shown in Table 2, the variation in B/A for a Macchi fitted with 320 1 tip tanks changes considerably as the tip fuel is used. The consequent variation in spinning characteristics of the standard aircraft with different fuel states has been documented in detail in TS 1596. Removal of the tip tanks causes a further increase in the B/A ratio and can therefore be expected to markedly affect spinning characteristics. In this configuration, the yawing moment of inertia may be difficult to balance, hence the aircraft will probably be more reluctant to spin and the developed spin more oscillatory. The effect of controls in recovery from a spin is also very sensitive to mass distribution. For an aircraft where $B/A > 1.3$ the following general statements can be made:

- a. In-spin aileron (ie. with roll) has anti-spin effect;
- b. Down elevator has a pro-spin effect on the inertia yawing moment but this may be modified by other factors (eg. anti-spin moment due to directional stability); and
- c. Opposite rudder (ie. against the yaw) has an anti-spin effect which increases as B/A increases.

The modified aircraft should therefore recover from a spin more easily if the controls are used correctly (ie. full opposite rudder, aileron and elevator neutral, although in-spin aileron can be used if necessary). However, recovery from the spin could be delayed considerably if incorrect control inputs are made. Model spinning tests were carried out by RAE, Farnborough in 1956 and the results of that study support conclusions made in this paragraph. In summary,

the modified aircraft, when compared to the standard configuration, can be expected to be more reluctant to spin, have a more oscillatory spin, and recover more easily provided the correct control inputs are made. However, incorrect use of the controls may considerably delay recovery.

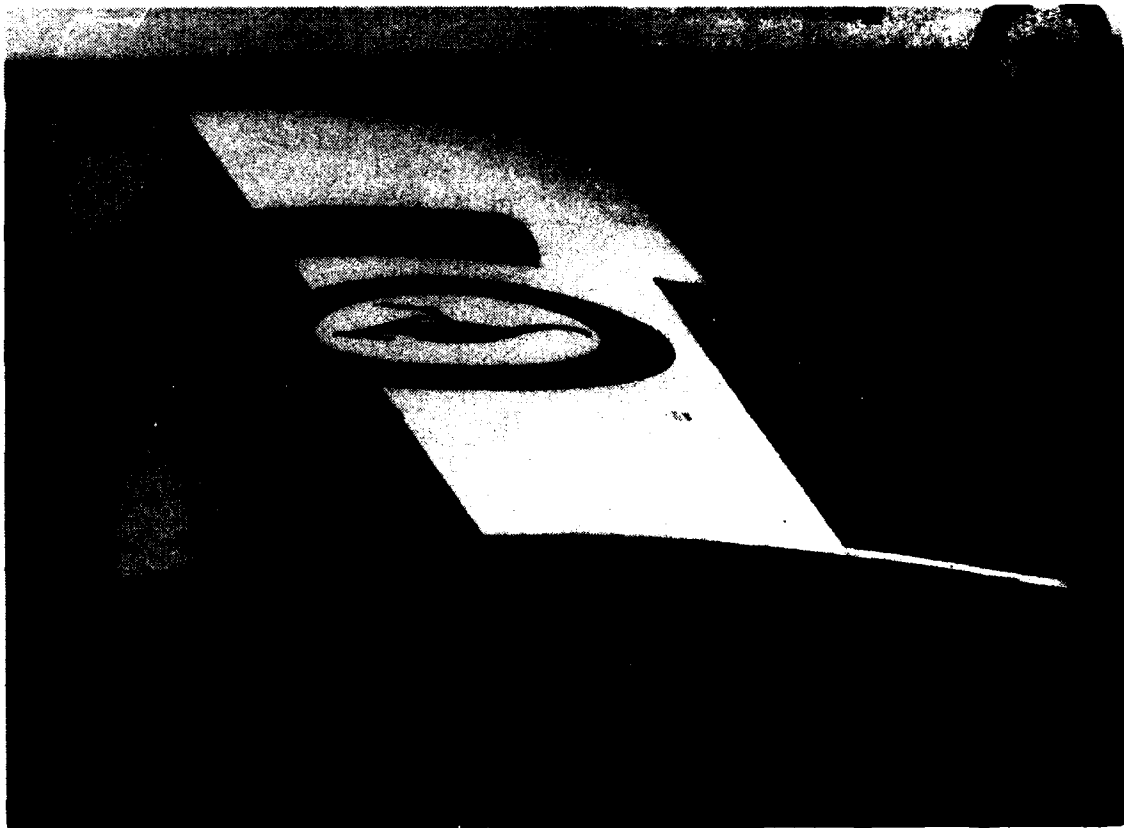
7. Wing Tip Shape. Tip tanks have similar effects to end-plates in that they increase the effective Aspect Ratio. This leads to reduced induced drag and increased lift curve slope. Removal of the tip tanks can therefore be expected to have the opposite effect. This should not directly affect the aircraft's handling but may influence its characteristics at low speed. Any significant increase in induced drag could result in reduced speed stability due to a rapid increase of total drag as speed is reduced. The end-plate effect of the tip tanks probably also has a beneficial influence on aileron effectiveness. Removal of the tanks will probably reduce the aileron power, especially at low speeds. Consequently, reduced lateral control may occur during take-off, approach and landing although reduced roll inertia and roll damping may somewhat offset the reduction in aileron power. Removal of the tanks also reduces the wing area and may lead to increased stall speeds for given AUWs. In general, the modified aircraft may have higher stall speed and poorer lateral control at low speeds which may require the use of higher take-off and approach threshold speeds.

ANNEX B TO
REPORT NO TN AERO 73

GENERAL VIEW OF MB-326H WITH TIP TANKS REMOVED



CLOSE-UP VIEW OF WING TIP FAIRING FITTED TO MB-326H



AIRCRAFT RESEARCH AND DEVELOPMENT UNIT

TECHNICAL NOTE AERO 73

LIMITED ASSESSMENT OF MACCHI MB-326H HANDLING
CHARACTERISTICS WITHOUT TIP TANKS FITTED

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